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Epidemiology of Birth Before hospital Arrival in Himachal Pradesh, India

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Abstract

***Background:** Obstetric-related mortality is high in India. Due to delays in accessing care and barriers to transport, many births are attended by emergency medical technicians (EMTs). Understanding the trends in use of emergency services may help government decision-makers improve services and safety for Indian mothers and newborns.*

***Methods:** 807,548 calls received between December 2010 and March 2017 by emergency call centers in the Indian State of Himachal Pradesh were reviewed. The emergency call location, transport type (primary [PT] or inter-facility [IFT]) and outcomes (Birth Before Arrival [BBA] or transport undelivered) were identified. Median response and transport times were calculated. Chi-square tests of independence were performed.A subset of BBAs was reviewed to determine complications encountered and intervals from emergency call to BBA.*

***Results:** Of 807,548 total emergency calls there were 166,523 pregnancy-related calls (20.6%). 159,119 pregnant women (95.6%) were transported undelivered and 7,404 (4.4%) experienced a BBA.64.5% of BBAs occurred in the ambulance and 35.5% at the scene. Over time, IFT increased from 9.4% to 21.9% of pregnancy calls ($p<0.01$), and BBAs increased from 3.9% to 4.5% ($p<0.01$). The most sparsely-populated Districts had the highest rates of IFTs and BBAs. Complications were seen in 41% of the 387 women experiencing BBAsand 6.4% of their neonates.*

***Conclusions:** Twenty percent of calls for EMT services in the Indian State of Himachal Pradesh are pregnancy-related. The rates of inter-facility transport and birth before arrivalhave increased. Opportunities for safe and expeditious emergency transport of pregnant patients should be maximized to improve safe motherhood in India.*

Keywords: Maternal mortality; Emergency management systems; Safe delivery; Simulation; Health care delivery; Birth before arrival.

Introduction

The 2017 Indian National Health Policy (NHP)was created to define the type and scope of supportthat the Government of India would provide for health systems strengthening at many levels such as infrastructure, human resources, prevention, education and finance (1). One specific goal of theNHP wasto reduce the national MMR from 174 to 100 per 100,000 live births by 2020 (1,2).The annual rate of improvement in MMR in India has been 4.7% over the past decade; this will need to increase to 10% annually to reach the NHP goal (2). Large-scale programs at multiple levels are used in India to reduce maternal and neonatal mortality (2). For example, safe motherhood programs (e.g. Janani

Suraksha Yojana [JSY] and Janani Shishu Suraksha Karyakaram [JSSK])have increased institutional deliveries and encouraged care-seeking behavior. Funded by the National Health Mission, JSY and JSSK cover all prenatal and delivery services at no cost to the patient.Medical colleges have opened maternal-child wings to provide specialist services to pregnant women. Other programs have been developed to provide iron and folate supplements, treat intestinal parasites, support adolescents with peer counseling, and train rural physicians to provide emergency obstetric care including cesarean sections.

A successful,multi-faceted approach to safe delivery also includes safe and expeditious transportof laboring or complex obstetric patients tofacilities with a skilled birth attendant. Patients who deliver prior to arrival at a skilled facility are at higher risk of complications than those who deliver in the hospital, particularly if there are complications such as prematurity or preeclampsia (3).

In India, transport is often provided by ambulance services provided by a public-private partnership called GVK Emergency Management and Research Institute (EMRI,http://www.emri.in/). EMRI emergency medical technicians (EMTs) have assisted 475,000 emergency deliveries from launch in 2005 through August 2017 (4). This is thought to be the largest number of out-of-hospital deliveries managed by an emergency management system (EMS) in the world.

The objective of this study was to document pregnancy-related emergency calls and births before arrival at a skilled facility in Himachal Pradeshin order to better understand the use of emergency transport services and the outcomes of transport events in this region. This information will be useful to stakeholders designing, implementing, and evaluating interventions to improve safe delivery in India with the goal of reducing the MMR.

Methods

Definitions

"Birth Before Arrival" or BBA is defined as either A) a birth than occurs in an inappropriate location, usually outside a health facility, regardless of whether there is an appropriate health practitioner present; or B) a birth that occurs without a skilled birth attendant, regardless of location. For an EMT, this includes an unplanned delivery with an EMT while still at home, *en route* to the hospital ("primary transport" or PT) or during transport from one facility to another ("inter-facility transport" or IFT).

Setting

The study data came from the northern Indian State of Himachal Pradesh, located in the foothills of the Himalaya Mountains with a total population of 6.8 million (90% rural, 10% urban) (5). This State has historically low rates of skilled birth attendance and seasonal and district-level variations in accessing health services, related in part to the difficult terrain. The MMR for Himachal Pradesh is part of a pooled estimate of all Indian States with fewer than 100,000 live births annually; in 2013 it was estimated at 115 (6).

A total of 807,548 emergency calls for all causesfrom 25 December 2010 to 31 March 2017 were analyzed. The care provided to each patient was recorded in a paper "Patient Care Record" created by the EMT at the scene. Patient Care Recordswere reviewed and logged by centralized staff at GVK EMRI including senior EMTsand emergency medicine physicians.

Data Analysis

The emergency call location (District and level of care at origination and destination) and outcomes (BBA or transport undelivered) were compared by District, year, type of transport (primary transport or inter-facility transfer), occurrence and location of any birth, and time required for ambulance response and transport to hospital. Median response times and call-to-hospital times were calculated.Chi-square tests of independence were performed to assess the significance of changes over time in rates (total pregnancy calls that were PTs vs IFTs, total BBAs, and percent of BBAs occurring during PT, IFT and at the scene versus in the ambulance).

A separate Patient Care Record review was completed by GVK EMRI staff for 387 BBAs that occurred between Oct 2016 and March 2017. This review was done to determine the types of complications encountered by EMTs and the intervals from initial emergency call to BBA.

Results

Pregnancy Calls, Primary Transfers and Inter-Facility Transfers

Emergency servicesrespondedto 166,523 pregnancy calls from 25 Dec 2010 to 31 March 2017. This was 20.6% of all emergency calls in the same time frame. From 2011-12 to2016-17, the total annual emergency calls increased from 109,058 to 163,447, while the proportion of pregnancy calls remained essentially unchanged from 22,112 (20.3%) to 33,756 (20.7%).

The proportion of PT fell from 20,030(90.6% of pregnancy calls) to 26,377 (78.1% of pregnancy calls) (p<0.01). IFT increased from 2082 (9.4% of pregnancy calls) to 7379 (21.9% of pregnancy calls) (p<0.01). See **Table 1** fortotal pregnancy calls, PTs, and IFTs by year.

Table 1. *Total pregnancy calls, PTs, and IFTs by year*

Year	Total Pregnancy Calls	PTs	IFTs
2010-11	2382	2082 (87.4%)	300 (12.6%)
2011-12	22112	20030 (90.6%)	2082 (9.4%)
2012-13	21943	20128 (91.7%)	1815 (8.3%)
2013-14	24006	21294 (88.7%)	2712 (11.3%)
2014-15	28977	24233 (83.6%)	4744 (16.4%)
2015-16	33347	27089 (81.2%)	6258 (18.8%)
2016-17	33756	26377 (78.1%)	7379 (21.9%)
TOTAL	**166523**	**141233 (84.8%)**	**25290 (15.2%)**

Births Before Arrival

Of the total 166,523 pregnancy calls, 159,119 pregnant women (95.6%)were transported undelivered to the hospital and 7,404 (4.4%) experienced a BBA. The vast majority of BBAs (6895 [93.1%]) occurred during PT and 509(6.9%) during IFT. **Table 2**displays the annual percentage of deliveries that occurred at the scene versus in the ambulance and the percentage during PT versus IFT. Overall, 4772 (64.5%) occurred in the ambulance and 2632 (35.5%) were delivered at the scene.

Table 2. *Births by arrival (BBA) by year, primary versus inter-facility transport and delivery location*

Year	Total BBAs	BBA during PT	BBA during IFT	BBAs in ambulance	BBAs at the scene
2010-11	61	56	45	61 (100%)	0
2011-12	862	815	47	653 (75.8%)	209 (24.2%)
2012-13	972	931	41	608 (62.6%)	364 (37.4%)
2013-14	1125	1078	47	672 (59.7%)	453 (40.3%)
2014-15	1342	1243	99	837 (62.3%)	505 (37.6%)
2015-16	1532	1409	123	996 (65.0%)	536 (35.0%)
2016-17	1510	1363	147	945 (62.6%)	565 (37.4%)
TOTAL	**7404 (4.4% of total pregnancy calls)**	**6895 (93.1 % of BBAs)**	**509 (6.9 % of BBAs)**	**4772 (64.5% of BBAs)**	**2632 (35.5% of BBAs)**

Total BBAs increased over time from 3.9% (862 out of 22122 total pregnancy-related calls) in 2011-12 to 4.5% (1510 out of 33756 calls) in 2016-17 (p<0.01). BBAs that occurred during PT also increased from 4.1% (815 out of 20,030 PTs) in 2011-12 to 5.2% (1363 out of 26,377 PTs) in 2016-17 (p<0.01). BBAs during IFTs did not significantly change over time from 2.3% (47 out of 2082 IFTs) in 2011-12 to 2.0% (147 out of 7379 IFTs) in 2016-17 (p=0.45). IFTs that resulted in BBA (n=509) originated at the following

facilities: civil hospital (249, 48.9%), community health center (130, 25.5 %),primary health center (76, 14.9%), regional or zonal hospital (43, 8.5%), or medical complex (11, 2.1%). In the Indian health system, medical complexes and civil, regional, and zonal hospitals should meet Comprehensive Emergency Obstetric and Newborn Care (CEmONC) criteria. Community and primary health centers should meet Basic Emergency Obstetric and Newborn Care (BEmONC) criteria.

The proportion of BBAs occurring at the scene (as opposed to in the ambulance) increased from 24.0% (209 out of 862 BBAs) in 2011-12 to 37.0% (565 out of 1510 BBAs) in 2016-17 (p<0.01).

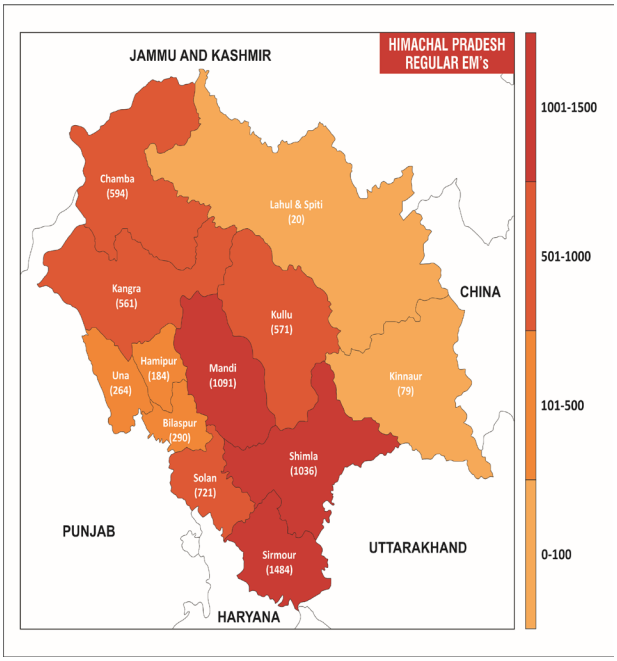
Response and Transport Times

Average time from call to reaching the patient was 29 minutes for PTs and 13 minutes for IFTs. The time from call to reaching the hospital was 77 min for PTs and 176 min for IFTs. Average time from call to BBAwas 32 minutes for PTs and 58 minutes for IFTs.

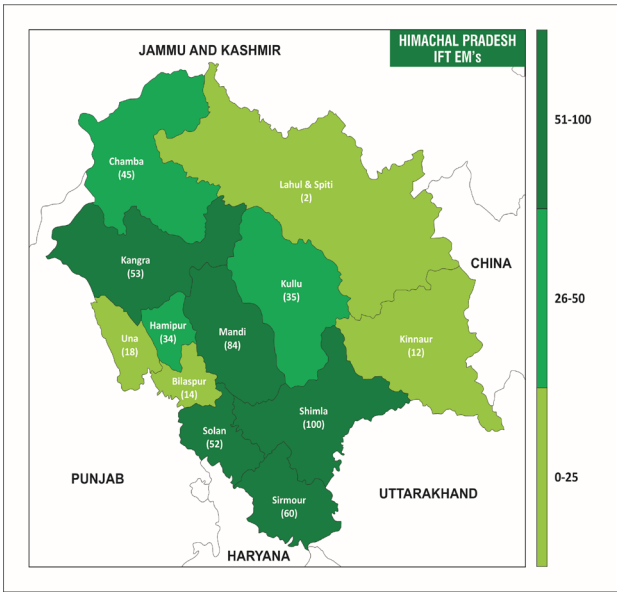
District-level data

There was variation in numbers of total pregnancy calls, ranging from 248 in Lahaul-Spitito 31,335 in Kangra). The percentage of total pregnancy calls that were IFTs also varied, ranging from 1096 (11.6%) in Bilaspur to 65 (26.2%) in Lahaul-Spiti. The average percent of IFTs across all Districts was 15.8%. See **Appendix A** for deliveries by District.

BBAs as a percentage of total pregnancy calls occurred at an average rate of 4.4% across Districts (range:1.8% in Harmipur to 9.2% in Kinnaur). BBAs occurred in the ambulance (as opposed to at the scene) an average of 64.5% across Districts (range:53.2% in Una to 72.5% in Kinnaur).See **Figure 1** for District-level heat maps of BBAs during PTs (**Figure 1A**) and IFTs (**Figure 1B**). See **Appendix A** for BBAs by District. The two most sparsely-populated Districts (Lahaul-Spiti [2 persons per km^2] and Kinnaur [13 persons per km^2]) had the highest rates of IFTs and BBAs. District variation in transport times was large with 7 hours for call to reaching hospital for IFTs in Lahaul-Spiti.



1A. During primary transport



1B. During inter-facility transport

Figure 1. *Number of births before arrival by District of Himachal Pradesh*

Complications during BBAs

A subset of 387 Patient Care Records for BBAs that occurred between October 2016 and March 2017 was reviewed. Forty seven BBAs occurred during IFT and 340 occurred during PT. **Table 3** displays fetal presentation and estimated gestational age

for these cases. Clinical complications were seen in 41% (159 out of 387) of women and 6.4% (25 out of 389) of their neonates. See **Table 4** for maternal and neonatal complications sought during case review. No complications other than those listed in **Table 4** were tabulated (including no maternal or neonatal deaths).

Table 3. *Fetal presentation and estimated gestation during birth before arrival (BBA)*

	During primary transport (n=340 BBAs)	During inter-facility transport (n=47 BBAs)
Term	326 (95.9%)	40 (85.1%)
Preterm (<37 weeks gestation)	14 (4.11%)	7 (14.9%)
Cephalic	329 (96.8%)	42 (89.63%)
Breech	11 (3.20%)	5 (10.63%)

Table 4. *Complications encountered during birth before arrival, combined primary and inter-facility transport (n=387 mothers, 389 neonates)*

Type of complication	Total number and rate of complication
MATERNAL	
Hypertension	65 (40.0%)
Hypotension	48 (30.0%)
Hemorrhage	24 (15.0%)
Hypoxia (SPO2 less than 95%)	13 (8.0%)
Cord prolapse	4(4.1%)
Anemia	3 (3.1%)
Non-progressive labor	2 (3.1%)
Hepatitis B	1 (1.0%)
TOTAL MOTHERS WITH COMPLICATIONS	160 (41.3%) *
NEONATAL	
Hypoxia (SPO2 less than 95% by pulse oximeter) within 5 minutes of birth	17(37.7%)
Infant requires ventilation with bag-valve mask	2(4.4%)
Nuchal cord	2(4.4%)
Infant requires cardiopulmonary resuscitation	1(2.2%)
Prematurity (<37 weeks gestation)	21(48.8%)
Meconium present	1(2.2%)
Prolapsed Cord	1(2.2%)
TOTAL NEONATES WITH COMPLICATIONS	45 (11.6%)*

* Note some women and neonates had more than one complication

Discussion

Births before arrival (BBAs) are potentially high-risk events with complications such as fetal hypoxia, placental abruption, shoulder dystocia, postpartum hemorrhage, and preeclampsia (3). Premature neonates are at very high risk of complications (7). The risks to mother and fetus are likely increased with increased transport times to a skilled facility (8,9). Mothers in one study were aware of possible complications associated with BBA (3). Women who experience BBAs are more often disconnected from routine prenatal care and may have other risks such as lack of family support or poverty (10).

To reduce risk of maternal and neonatal morbidity and mortality, deliveries are ideally performed in a skilled facility with clinicians such as physicians or midwives attending the birth. However, our study showed that emergency medical technicians (EMTs) in Himachal Pradesh (HP) were called upon to address obstetric emergencies and attend deliveries at least 12-15 timesmore frequently than in other parts of the world. For example, a4-year study of approximately 200,000 emergency calls from Helsinki, Finland, identified 799 (0.4%) emergencyobstetric calls and 103 (0.05%) BBAs (11). In 12 months in Victoria, Australia, there were 462,830 total emergency calls, of which 4096 (0.8%) were maternity emergencies and 324 (0.07%) BBAs (12). In contrast, the EMTs in our study managed obstetric issues in 1 of 5 total emergency calls and in about 1 of 100 total calls managed a BBA.In 2013-14, 26% of patients who delivered in an HP institution used EMS to reach the health facility (5).

In addition to documenting the overall heavy use of EMS for pregnancy-related care, we identified increases over time in the following:

- Percentage of pregnancy calls that were IFTs rather than PTs
- Rate of BBA
- Rate of BBA during PT
- Rate of BBA occurring at the scene rather than during transport

Why these trends are occurring are unknown but could to be related tochanges in many factors that inform the decisions of patients, families and health workers regarding when and where to seek care (**Table 5**). The most sparsely populated Districts had the highest rates of BBAs and IFTs. How the relative importance of above factors varies by District is unknown. Other important factors affecting these decisions may not yet be identified.

Table 5. *Factors affecting how and when patients receive obstetric care*

FACTOR	EXAMPLES
Socioeconomic or cultural	• Literacy • empowerment of women • poverty • availability of personal transportation • traditional preference for home delivery
Patient	• trust in emergency services as compared to locally available services • incidence of infection, multiparity, precipitous or preterm labor
Emergency medical services	• call center physician advice to EMTs (e.g. EMT directed to deliver patient at the scene instead of trying to reach the hospital) • availability of ambulance services • comfort level of the EMT in managing a delivery
Maternity services	
provider behavior	• preference of local care provider to refer to higher level of care • ability of antenatal care and field workers to provide information and advocacy about when and how patients should seek care
level of care available locally	• Perceived capabilities • Actual services available ○ inadequate obstetric or neonatal experience, facilities or therapies such blood bank or medications ○ lack of waiting areas or “lying-in homes” for patients at high risk of complications or who live far from the hospital ○ super-specialty hospitals in nearby Indian States may advertise to patients, creating a perception that complications can’t be cared for locally ○ inadequate overnight staff
Non-health care factors	• public transportation may be more readily available during the day • sparse population creates little incentive for local, private hospitals to start up • lack of security at night may deter mothers from travelling

Decreasing India's MMR will require increased access to birthing facilities staffed continuously with a skilled birth attendant and toother BEmONC standards. However, it is unlikely that in sparsely-populated, impoverished, and/or geographically challenging areas that this access will be equitable. Our study demonstrated that transfers were at times even needed from oneCEmONC-capable facility to another, presumably to access clinicians, blood products, medical equipment or other critical items not available in what should have been a comprehensively-stocked and staffed facility. For these reasons, emergency services may be critical to achieving access to functional obstetric services. This access is achieved by stabilization of the emergency by an EMT and rapid, reliable transport to skilled facilities (13). Although an EMT is not traditionally considered a skilled birth attendant, emergency skills training with courses such as Advanced and Basic Life Support in Obstetrics may improve their ability to recognize and stabilize common obstetric and neonatal emergencies (12,14). This training is already standardized for GVK EMRI call center and ambulance staff.

EMT interventions do not require costly or uncommon skills or equipment. For example, the majority of depressed newborns require only brief bag-mask ventilation using room air to transition to extra-uterine life (15). Mobile EMS units could increase rapid access to oxytocin, magnesium sulfate, and materials such as sterile blades and umbilical ties for safe cord care. These interventions should be considered powerful opportunities for prevention that may mitigate or prevent more serious complications such as postpartum hemorrhage, eclamptic seizure or neonatal tetanus that have grave and expensive consequences for patients, families, and health systems.

Ambulances could potentially be used in other ways to support safe motherhood such as to transporting women to antenatal care visits or caregivers to isolated communities. Institutional delivery may be more attractive to patients and families if a "drop-back" service is offered to return the patient home after delivery.In conjunction with creative use of the EMS, hospitals and other birthing facilities must develop appropriate monitoring and feedback mechanisms so that all health institutions better understand not only birth outcomes occurring in the institutions but also during transfers to other facilities (16). Unnecessary PT, IFT and BBA put patients at risk and waste resources.

Appendix A: *Pregnancy emergency calls and births before arrival (total, primary transfers and inter-facility transfers) by District*

District	Population Density Pop'n (2011)/area sq km*	Pregnancy calls	PT (percent of total pregnancy calls for the District)	IFT (percent of total pregnancy calls for the District)	Total BBAs (percent of total pregnancy calls for the District)	BBA in ambulance (percent of total BBAs in District)	BBA at scene
BILASPUR	327	9410	8061	1096 (11.6%)	304 (3.2%)	190 (62.5%)	114 (37.5%)
CHAMBA	79	12080	10535	1545 (12.8%)	639 (5.3%)	427 (66.8%)	212 (33.2%)
HAMIRPUR	406	11960	8728	1530 (12.8%)	218 (1.8%)	127 (58.3%)	91 (41.7%)
KANGRA	262	31335	25058 (80.0%)	6277 (20.0%)	614 (2.0%)	369 (60.1%)	245 (39.9%)
KINNAUR	13	994	773	221 (22.2%)	91 (9.2%)	66 (72.5%)	25 (27.5%)

KULLU	79	9271	8175	1349 (14.6%)	606 (6.5%)	414 (68.3%)	192(31.7%)
LAHAU L-SPITI	2	248	183	65 (26.2%)	22 (8.9%)	14 63.6%)	8 (36.4%)
MANDI	253	23340	20339	3232 (13.8%)	1175 (5.0%)	767 (65.3%)	408 (34.7%)
SHIMLA	158	18912	16469	2551 (13.5%)	1136 (6.0%)	725 (63.8%)	411 (36.2%)
SIRMAUR	188	19291	17311	3001 (15.6%)	1544 (8.0%)	1077 (69.8%)	467 (30.2%
SOLAN	303	17573	15022	2443 (13.9%)	773 (4.4%)	446 (57.7%)	327 (42.3%)
UNA	338	12109	10579	1980 (16.4%)	282 (2.3%)	150 (53.2%)	132 (46.8%)
Total		**166523**	**141233**	**25290 (15.8%)**	**7404 (4.4%)**	**4772 (64.5%)**	**2632 (35.5%)**

*population density from reference 17

Limitations

This study is a snapshot of the pregnancy-related patterns of use of a large EMS in India, but the underlying causes of the patterns were not addressed. Although GVK EMRI provides the vast majority of EMS in HP, some pregnant patients may have used private ambulances for transport. The use of paper record review may increase the risk of tabulation errors as compared to automated or computer-based data collection. The EMTs on-site for the emergency transport are creating the Patient Care Records at the time of service. This decreases inaccuracies associated with later recall of events but relies upon the EMTs to diagnose complications, which may not be fully known at the time of transport.

Conclusions

This report should be a catalyst for initiating discussion and prompting action on new paradigms to meet the Government of India's goal of reducing maternal mortality to 100 deaths per 100,000 live births by 2020. Pregnancy-related emergency calls are occurring in the Indian State of Himachal Pradesh 12-15 times as often as emergency services in other countries. Over time, rates of births occurring before arrival to a skilled facility have increased. Indian EMTs therefore need to be trained in emergency obstetric delivery and stabilization of mother and newborn. Emergency services provide a non-traditional means of increasing maternal and neonatal access to lifesaving interventions and medications, especially for those areas with individual, cultural or geographic barriers to seeking delivery care.

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